

WHAT IS CLAIMED IS:

1. A voltage controlled oscillator comprising:
 - a current source that is configured to generate a first current having a first negative temperature coefficient;
 - a current sink that is configured to generate a second current, a current level of the second current varying in response to a first voltage level of a control voltage, the second current having a second negative temperature coefficient; and
 - a frequency generator that is configured to generate an oscillating signal having a frequency corresponding to a difference between the first and second currents.

2. The voltage controlled oscillator of claim 1, wherein the current source includes:

- 15 a reference current source that is configured to generate a reference current;
- a voltage generator that is configured to receive the reference current to generate a bias voltage based on the reference current; and
- a current mirror circuit that is configured to generate the first current, the first current being substantially a same current as the reference current.

- 20 3. The voltage controlled oscillator of claim 2, wherein:

the voltage generator includes:

a first transistor, a second current electrode of the first transistor receiving the reference current, the second current electrode of the first transistor being connected to a control electrode of the first transistor, and

a second transistor, a control electrode of the second transistor being connected to the control electrode of the first transistor; and

the current mirror circuit includes:

a third transistor, a second current electrode of the third transistor being connected to the second current electrode of the second transistor, the second current electrode of the third transistor being connected to a control electrode of the third transistor, and

a fourth transistor, a control electrode of the fourth transistor being connected to the control electrode of the third transistor.

10

4. The voltage controlled oscillator of claim 1, wherein the current sink includes:

a voltage level shifter that is configured to convert the first voltage level of the control voltage into a second voltage level to generate a first voltage having the second voltage level, and is configured to generate the second current corresponding to the first voltage; and

a current subtractor that is configured to subtract the second current from the first current.

20 5. The voltage controlled oscillator of claim 4, wherein the voltage level shifter includes:

a first level shifter that is configured to convert the first voltage level of the control voltage into the second voltage level to generate the first voltage having the second voltage level; and

a second level shifter that is configured to convert the second voltage level of the first voltage into a third voltage level to generate a second voltage having the third voltage level.

5 6. The voltage controlled oscillator of claim 5, wherein the first level shifter includes:

a first transistor, a control electrode of the first transistor receiving a bias voltage based on a reference current;

10 a second transistor, a control electrode of the second transistor receiving the control voltage, a first current electrode of the second transistor being connected to a second current electrode of the first transistor,

and wherein the second level shifter includes a third transistor; a control electrode of the third transistor receiving the first voltage from the first level shifter, a first current electrode of the third transistor being connected to the current subtractor.

15 7. The voltage controlled oscillator of claim 1, wherein the frequency generator includes:

a ring oscillator that is configured to generate a first oscillating signal having the frequency corresponding to the difference between the first and second currents; and

20 a buffer that is configured to convert a swing width of the first oscillating signal into a full swing width to generate the oscillating signal.

8. A voltage controlled oscillator comprising:

a voltage generator that is configured to generate a bias voltage based on a

reference current;

a current mirror circuit that is configured to generate a first current, the first current being substantially the same current as the reference current and having a first negative temperature coefficient;

5 a first level shifter that is configured to convert a first voltage level of the control voltage into a second voltage level in response to the bias voltage to generate a first voltage having the second voltage level;

10 a second level shifter that is configured to convert the second voltage level of the first voltage into a third voltage level to generate a second voltage having the third voltage level, and configured to generate a second current corresponding to the second voltage and having a second negative temperature coefficient;

15 a current subtractor that is configured to subtract the second current from the first current to generate a third current;

a ring oscillator that is configured to generate an oscillating signal having a frequency corresponding to the third current; and

20 a buffer that is configured to convert a swing width of the oscillating signal into a full swing width.

9. A method of generating an oscillating signal, the method comprising:

20 generating a first current having a first negative temperature coefficient based on a reference current;

generating a second current, a current level of the second current varying in response to a first voltage level of a control voltage, and the second current having a second negative temperature coefficient;

generating a third current corresponding to a difference between the first and second currents; and

generating the oscillating signal having a frequency corresponding to the third current.

5

10. The method of claim 9, wherein said generating a second current includes:

converting a first voltage level of the control voltage into a second voltage level to generate a first voltage having the second voltage level;

10 converting the second voltage level of the first voltage into a third voltage level to generate a second voltage having the third voltage level; and

generating the second current corresponding to the second voltage.